London Office:
16, Victoria Street,
Westminster.

A NEW SYSTEM

OF

SOFTENING

AND

PURIFYING

HARD WATER

For Manufacturing Purposes, and for use in Steam Boilers.

1894

SOLE MANUFACTURERS:

MATHER & PLATT LTD.,
Salford Iron Works,
MANCHESTER.

A NEW SYSTEM

OF

SOFTENING AND PURIFYING HARD WATER

FOR MANUFACTURING PURPOSES, AND FOR USE IN STEAM BOILERS.

Protected by Letters Patent granted to

L. ARCHBUTT, F.I.C., *and* R. M. DEELEY, M.Inst., M.E.

SOLE MANUFACTURERS:

MATHER & PLATT LTD.,

Salford Iron Works,

MANCHESTER.

LONDON OFFICE:

16, VICTORIA STREET, WESTMINSTER.

MANCHESTER
PALMER, HOWE AND CO.,
PRINCESS STREET,

DESCRIPTION

OF THE

PLANT AND PROCESS FOR SOFTENING

AND

PURIFYING HARD WATER.

THE PURIFIER.

THE drawing represents a Purifier suitable for the treatment of from 5,000 to 10,000 gallons per hour. It consists of a cast-iron tank, measuring 32ft. × 16ft. × 10ft. deep, divided into two equal parts by a transverse partition of cast or wrought iron. The two tanks thus formed are fitted up exactly in the same way, and are intended to be used alternately, so as to maintain a continuous supply of softened water.

FILLING.

Hard Water is admitted to either tank by means of the Supply Pipe (1), which is connected up to a pump or main. The water is run in up to the level of the top of the well (4).

PREPARING THE CHEMICALS.

While the tank is filling, the proper quantities of Lime and Sodium Carbonate (58% Soda Ash) are weighed out, with the addition, in some cases, of a very small quantity of Aluminium Sulphate, or Alumino-ferric Cake, and these are boiled up with water in the small Chemical Tank (2), by means of steam from the steam pipe shewn in the drawing. Sometimes the Aluminium Salt is dissolved in a separate quantity of water and added separately.

ADDING THE CHEMICALS.

The Trajector (3) is put into action by opening its steam valve, and then the chemical liquid is run out of the chemical tank into the well. The trajector creates a powerful current of water from the well, through the projecting pipe, across the tank, and into this current the chemicals pass. The well, being open at the sides and bottom,

fills as rapidly as it empties, and by the circulation thus set up, rapid and thorough mixing of the chemicals and the hard water is effected.

ACCELERATED PRECIPITATION.

After the chemicals have been added and mixed with the water, and the trajector has been shut off, steam is admitted to the Blower (5), which causes air to be sucked down the orifice and forced out of the perforations in the pipes laid close to the bottom of the tank. The currents caused by the rising air-bubbles carry up some of the mud from the bottom of the tank, and thus diffuse throughout the water (in which the chemicals have produced a precipitate of fine particles) a large number of coarser and heavier particles, identical in crystalline structure with the fine particles. To these coarse particles, most of the fine particles soon become attached, and subsidence of the precipitate is thereby greatly accelerated when the water is allowed to rest; and the further advantage is gained, that the chemical reaction, which becomes very sluggish in its last stages, is promoted by the presence of a large number of crystalline particles in active movement throughout the water.

SETTLING.

After the blower has been in operation for fifteen minutes, the steam is turned off, and the water is allowed to rest. The result is, that in about thirty minutes, or from that to one hour, very nearly all the precipitate will have settled to the bottom of the tank, and the water, even down to a depth of six feet from the surface, will not contain on an average more than about one grain per gallon of suspended matter.

TESTING THE WATER.

River Waters, and others liable to variation, are tested at this stage as follows:—A little of the clear water is taken out of the softening tank with a dipper and poured into a small white basin containing a few drops of a solution of silver nitrate. If there be no excess of lime, a white milkiness will be produced, a slight excess of lime will cause a pale yellow colour, and a larger excess will produce a brown precipitate. We aim at getting the pale yellow colour. If the colour obtained be too pale, we add a pound or two more lime to the next tank; and if the colour be too dark, we add a pound or two less.

Traces of free lime do not injure the water for any purpose, as, by the subsequent carbonating process, all free caustic alkali is neutralised and converted into bi-carbonate.

DRAWING-OFF AND CARBONATING.

These operations are automatically and simultaneously effected by means of the Floating Discharge Pipe (9), of rectangular section. Fuel Gas from the Coke Stove (7), constructed so as to produce a minimum of carbonic oxide, is forced continuously by means of a very small steam blower (8), along the horizontal limb of the gas pipe, down the vertical limb, to the four-way junction, where there is an outlet for the condensed water; the gas passes thence up the sloping limb, through the side of the softening tank, to a small swivel which works concentrically with the large swivel of the discharge pipe; from the swivel the gas rises through a small pipe fixed to the discharge pipe, and finally enters the nozzle of the latter through the Gas Inlet (16) shewn in the enlarged section of the nozzle (15). On leaving the end of the inlet pipe, the gas is caught by the current of water flowing down the discharge pipe, which

is repeatedly splashed upwards by the ribs fixed at intervals along the bottom of the pipe, and in this way a thorough mingling of the gas and water is effected. The gas and water pass together through the Ball Tap fixed over the small Supply Tank (12) into which the softened and carbonated water falls, and from which it is drawn off for use, whilst the residual nitrogen, etc., of the fuel gas escapes into the air. If the small tank should fill up and cause the ball tap to close the outlet of the discharge pipe, the gas then accumulates in the pipe until the water in the nozzle is depressed below the orifice of the Gas Escape (17), up which the gas passes into the atmosphere without bubbling through and disturbing the water in the softening tank. A strip of Angle Iron fixed to the side of the tank, two feet from the bottom, indicates the level down to which the water is drawn off. Shortly before the water reaches this level the further descent of the discharge pipe is arrested by a hollow casting (10) perforated with a ring of holes. The whole or a portion of the hard water enters the tank through these holes and thus keeps the mud from accumulating near the discharge orifice.

REMOVING THE MUD.

The mud may be allowed to accumulate to a depth of about twelve inches, and may then be swept out of the tank through the Mud Doors (13), into a brick trough which conveys it into a drain, about one inch of mud being left in the tank to carry on the clarifying process. An alternative and generally preferable method is to utilize the perforated pipes at the bottom of the tank. The main blower pipe is extended through the side of the tank, and there terminates in a valve (14), by opening which for a few minutes at intervals the accumulation of mud beyond what is necessary for the clarifying process is prevented.

GENERAL REMARKS.

All the mechanical operations are very simple, and the labour involved is light. So far as labour is concerned it costs no more to soften 20,000 gallons at one time than to soften 2,000 gallons; and where the quantity of water required per diem is not large enough to warrant the cost of special labour it is better, where there is room, to erect a plant of greater capacity than is absolutely necessary, because then the number of softenings

per diem is lessened, and, as each softening takes only a few minutes, the boiler attendant can spare enough time to do what is required.

The softening tanks are also storage tanks; a point to be remembered when considering the space occupied. Existing storage tanks can be fitted up as softening tanks if of suitable size and shape.

The steam used by the Trajector and Blower together is only sufficient to raise the temperature of the water about 3° F., and, when the water is required for boilers, more or less of the heat is returned to the boilers and must not therefore be charged to the softening process; if we charge the whole of it, it amounts to very little.

The reasons for carbonating the softened water were fully explained in the paper read before the Society of Chemical Industry in June, 1891. Uncarbonated softened water forms a deposit in pipes, and especially in the feed apparatus of steam boilers, which may become very troublesome. This is not a peculiarity of water softened in our apparatus. In fact, the uncarbonated softened water produced by our process is, as we have proved, less likely to give trouble from deposit in pipes than water softened

by some other processes in which the chemicals are used in considerable excess and the same efficient means are not adopted for ensuring the completion of the chemical reaction. It must be distinctly understood that the amount of carbonic acid introduced into the softened water is very small, and simply has the effect of restoring the artificially-softened water to the condition of a naturally soft water.

ADVANTAGES CLAIMED.

The process is based upon correct scientific principles, in consequence of which we are able to soften water by means of the cheapest chemicals used in the most economical proportions. As the excess of alkali thus introduced into the water is quite small, the subsequent carbonating of the softened water is easily accomplished, and thereby a soft water is produced which is suitable for all purposes; it is palatable, forms no deposit in pipes or mains, and cannot injure the most delicate skin or fabric. By the system of treating the hard water in large volumes, intermittently, more reliable results are obtained than by any existing continuous process. The plant is cheap, and very simple; there is

nothing about it to get out of order, and there are no filters to become clogged.

OUTPUT.

In the following formula for two tanks:—

v = The number of gallons of softened water supplied continuously per hour.

x = The working capacity, in gallons, of each tank.

y = The number of minutes required to fill each tank.

z = The number of minutes required for settling.

$$v = \frac{60\,x}{25 + y + z}$$

By using three tanks instead of two the output is doubled.

The following table contains a few examples, a period of thirty-five minutes being allowed for settling:—

x=Working capacity of each tank or division.	y=Time required to fill a tank or division.	v=Yield per hour, with 2 tanks or divisions.	3 tanks or divisions.
12,000 galls	30 minutes	8,000 galls.	16,000 galls.
12,000 ,,	20 ,,	9,000 ,,	18,000 ,,
12,000 ,,	10 ,,	10,000 ,,	20,000 ,,
20,000 ,,	30 ,,	13,300 ,,	26,600 ,,
20,000 ,,	20 ,,	15,000 ,,	30,000 ,,
20,000 ,,	10 ,,	17,000 ,,	34,000 ,,

COST OF SOFTENING WATER.

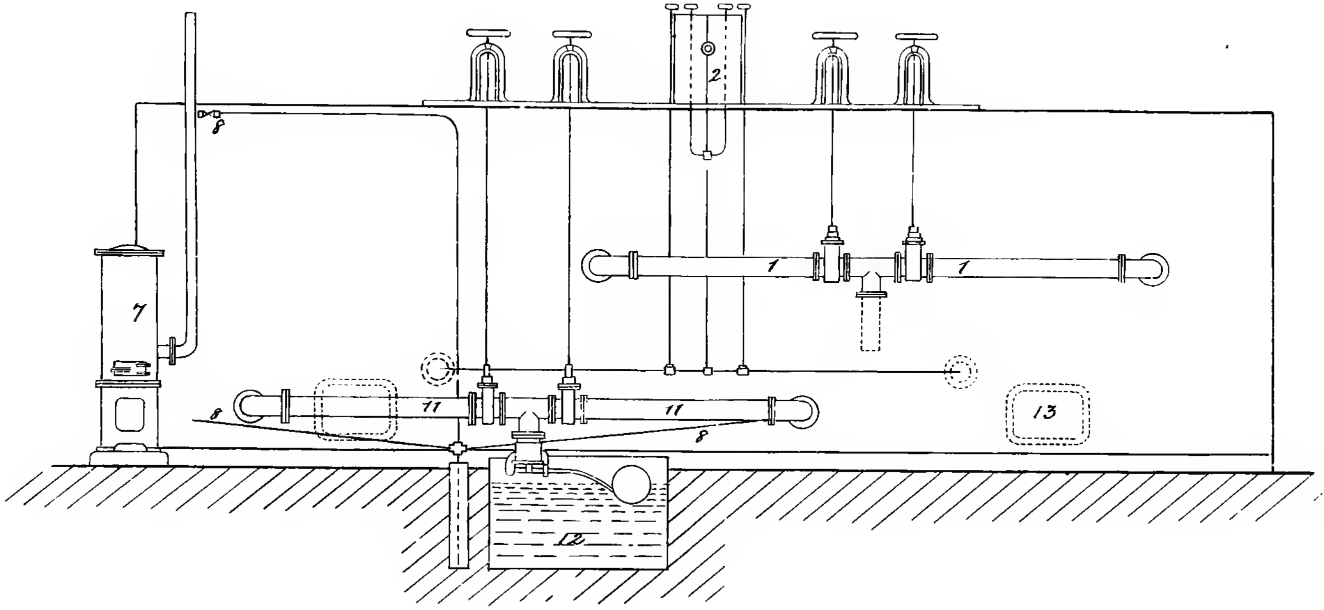
To remove Calcium Carbonate (carbonate of lime) from water costs very little, because lime alone is necessary, and is very cheap. To remove Calcium Sulphate (sulphate of lime), alkali must be used, which greatly increases the cost. Both lime and alkali are necessary for the removal of Magnesium Salts, and, what is more, the alkali has to be used in greater relative proportion. Waters containing much magnesium salts are therefore the more costly to treat. But the costliness of softening is, in many cases, a measure of the necessity for softening; and it is often the more economical to soften a bad water, which can be had for the pumping, than to purchase a town's water which is itself only less hard than the existing supply. In the following table the analyses of nine typical samples of water are given, together with the cost of the chemicals needed to soften each by our process, and reduce the hardness to from 3° to 5°.

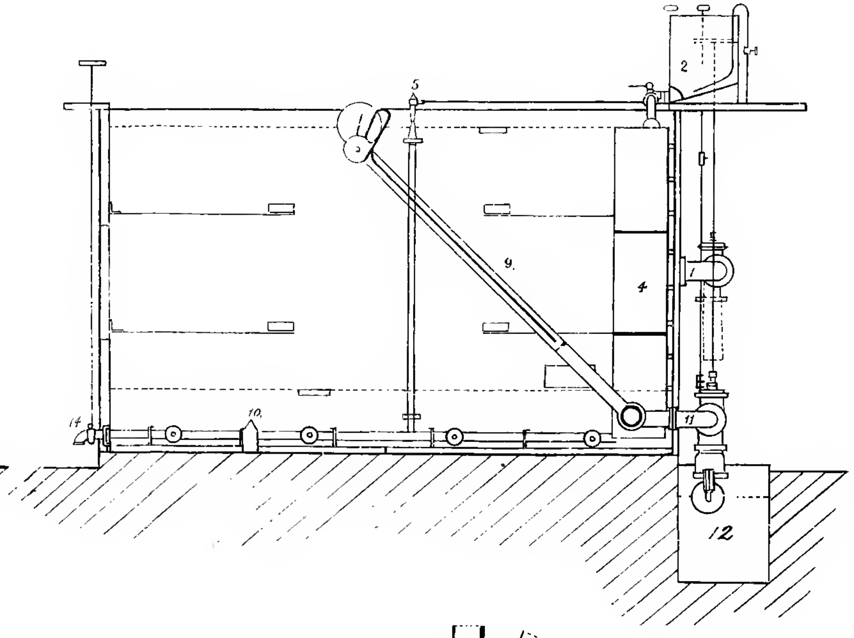
Number	1	2	3	4	5	6	7	8	9
	Grains per Gallon.								
Calcium Carbonate	8·74	13·15	16·39	10·99	9·19	2·06	9·41	8·34	1·39
Magnesium Carbonate	2·78	·33	·31	2·76	1·40	·94	1·00	2·82	1·78
Calcium Sulphate	3·26	......	4·30	2·99	12·17	47·34	22·91	40·61	54·14
Magnesium Sulphate	......	1·96	1·28	12·41	7·05	5·70	15·90	22·25	22·46
Sodium Sulphate	1·44	·30	......	18·96	......	9·98	......	2·65	28·96
Magnesium Nitrate	......	......	......	......	13·69	......	11·50	......	......
Sodium Nitrate	......	·96	small	......	......	......	......	small	......
Magnesium Chloride	......	......	......	......	·64	......	2·08	......	......
Sodium Chloride	2·72	2·06	3·05	5·28	6·30	6·77	5·05	6·35	5·28
Silica	·43	·39	·42	·31	·62	·62	·90	·84	·36
	19·37	19·15	25·75	53·70	51·06	73·41	68·75	83·86	114·37
Total Lime (Ca O)	6·24	7·36	10·95	7·39	10·16	20·64	14·70	21·39	23·07
Total Magnesia (Mg O)	1·33	·81	·58	5·48	7·02	2·36	9·82	8·81	8·38
Total Hardness (=*Calcium Carbonate equivalent to Total Lime and Magnesia*)	**14·5**	**15·16**	**20·99**	**26·77**	**35·53**	**42·7**	**50·57**	**60·02**	**61·95**
Cost of Chemicals required for softening 1000 gallons	¾d.	½d.	1d.	2d.	3½d.	4¾d.	5d.	6d.	7d.

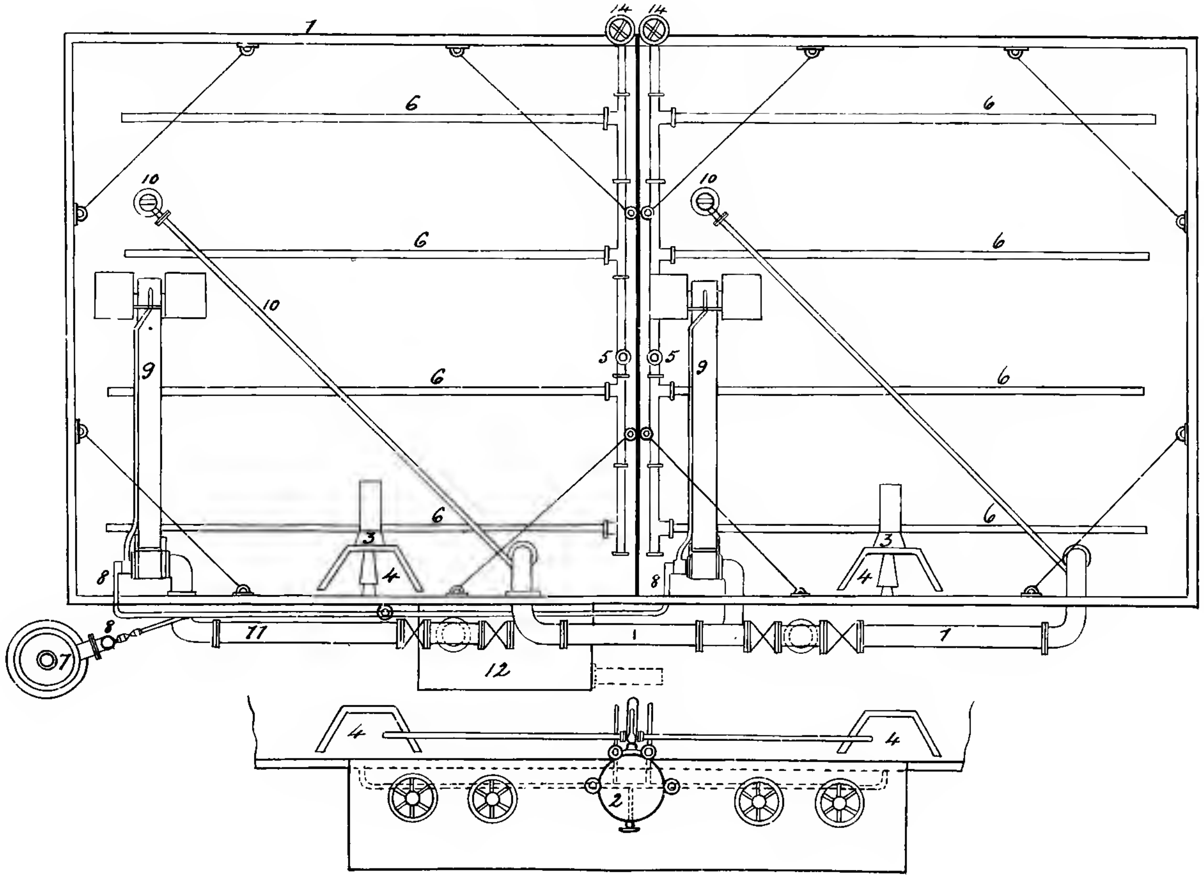
Note.—The above estimates of cost are based upon the following prices, viz.:—

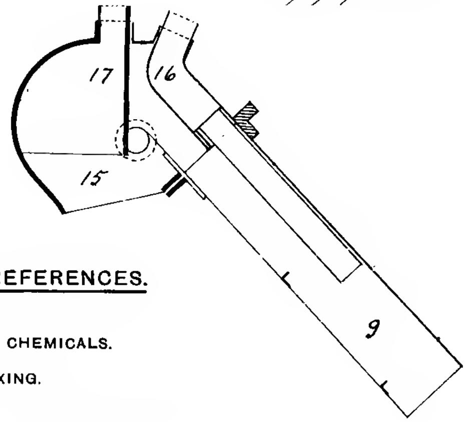
Quicklime .... at £1 0 0 per ton. | 58 % Soda Ash..................at £6 17 6 per ton.

PATENT HARD WATER PURIFIER.









LI[illegible] REFERENCES.

1. HARD WATE[illegible]PLY.
2. TANK FOR [illegible]ING CHEMICALS.
3. TRAJECTOR[illegible] MIXING.
4. WELL
5. BLOWER FOR AIR } FOR STIRRING MUD.
6. PERFORATED PIPES } FOR STIRRING MUD.
7. COKE STOVE.
8. BLOWER AND PIPE FOR FUEL GAS.
9. FLOATING DISCHARGE AND CARBONATING PIPE.
10. COMBINED REST FOR DISCHARGE PIPE AND INLET FOR HARD WATER.
11. FIXED DISCHARGE PIPE.
12. TANK WITH BALL TAP FOR SUPPLY OF PURIFIED WATER.
13. MUD DOOR.
14. VALVE FOR DISCHARGING MUD.
15. DISCHARGE NOZZLE.
16. GAS INLET.
17. GAS ESCAPE.

MATHER & PLATT LIMD.,
SALFORD IRON WORKS,
MANCHESTER.